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PASSIVHAUS RETROFITS IN ZURICH AND GRAZ
Lessons for Scotland

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IEA ECBCS Annex 50
Prefabricated Systems for Low Energy Renovation of Residential Buildings

Building Renovation Case Studies

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International Energy Agency
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Systems Programme

Renovation concept

Figure 5: View of renovated building

Design data of renovated building

Year of renovation	2009-10
Measurement period	July 2010-June 2011
Number of apartments	6
Heated floor area	657 m²
Total heating energy (incl. hot water)	13,257 kWh/y
Spec. energy consumption	20 kWh/(m²·y)
Heating energy savings (per m²)	88.6%
PV electricity gains	1 17,983 kWh/y
Rents (net)	120,000 €/y
Additional cost	3,000 €/y
Rent increase	39%

Key points of renovation

Maximization of living surfaces with the construction of a new attic apartment and an extension of the ground floors.

Renovation of the building envelope in Minergie-P standard (Passive House standard), with preservation of the architectural quality.

Substitution and installation of new building technology systems: new heating system, but keeping the old radiators, new ventilation system, new hot domestic water system, and new electric installations.

Use of renewable energy: ground source heat-pump, solar collectors, and horizontal PV-system on the roof.

Inner refurbishment: new bathrooms and kitchens

Refurbishment with taking care to recycle existing structures and materials, in order to minimize the consumption of grey energy.

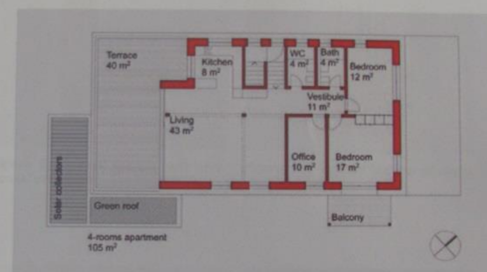


Figure 6: Floor plan of added penthouse apartment

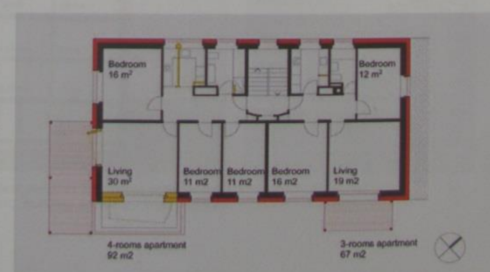


Figure 7: Floor plan showing the changes of the renovated building

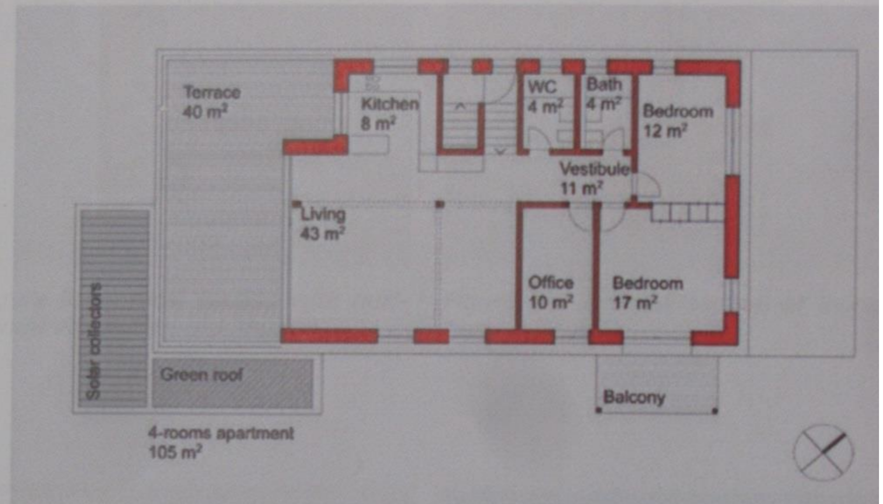


Figure 6: Floor plan of added penthouse apartment

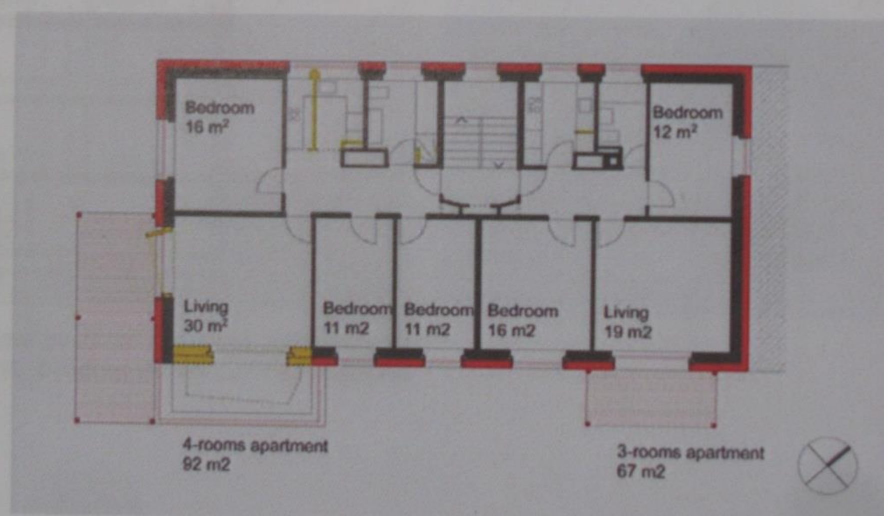


Figure 7: Floor plan showing the changes of the renovated building

Renovation design details

Façade solutions

The construction of the prefabricated large façade modules was a challenge. First measurements were taken by the University of Applied Sciences of North-Western Switzerl and by laser-measurements of the existing façades. The goal was to produce the elements based on this data. Because of difficulties to configure the data of the geometer to the needs of the architect, the contractor took also own measures. The new, large scale elements in timber construction had to fit on the imprecise and curved old walls. Because of this difficulty, cellulose insulation was used in order to fill all the gaps. The connections between the new windows and the old walls was covered by plasterboard and tightened by sealing tapes. The air-tightness of the renovated structure is excellent.

Wall construction

U-value: 0.18 W/(m²·K)		Prefabricated element:	
Interior rendering	10 mm	Tolerance / thermal insulation (cellulose)	20 mm
Brick wall	320 mm	Insulation (cellulose)	180 mm
Exterior rendering	20 mm	Wood fibre board	40 mm
		Exterior rendering	10 mm
		Total (incl. existing wall)	600 mm

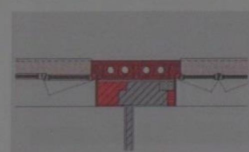


Figure 8: Horizontal section of façade element with integrated ventilation ducts

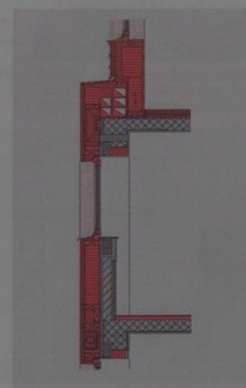


Figure 9: Vertical section with horizontal ventilation distribution

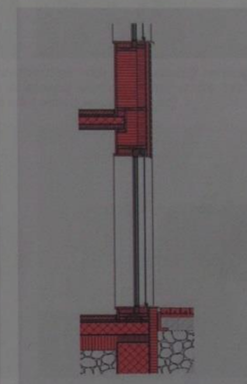


Figure 10: Vertical section of living room extension

Roof solutions

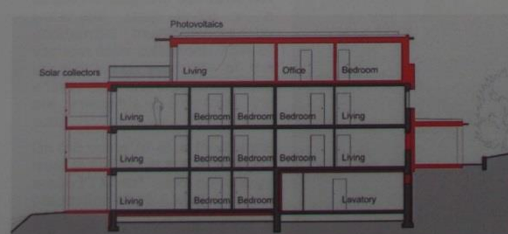


Figure 11: Vertical section of building. New parts in red (new balconies to the South, additional penthouse apartment, building annex for new heating system

Roof construction

U-value: 0.11 W/(m²·K)	
Three-layer slab	27 mm
Thermal insulation	360 mm
Three-layer slab	27 mm
Air space / Three-layer slab	200 mm
Polymer bitumen seal	10 mm
Recycled rubber mat	7 mm
Substrate geo-membrane	60 mm
Total	691 mm

From the 50's to the future

Net zero energy renovation of a Swiss apartment building in Zurich

Owners: Peter Rieben, Markus und Sara Rieben, Zürich
Architect: kämpfen für architektur, Zürich
Energy concept: René Naef, Zürich
Report: Nadja Grischott
Location: Zürich, Switzerland
Renovation: 2009-2010

Key technologies

- Large prefabricated wooden elements
- Façade integrated ventilation system
- Ground-source heat-pump with 260 m deep bore holes
- 12.5 m² vacuum solar collectors
- 16.1 kWp PV-system

Construction process

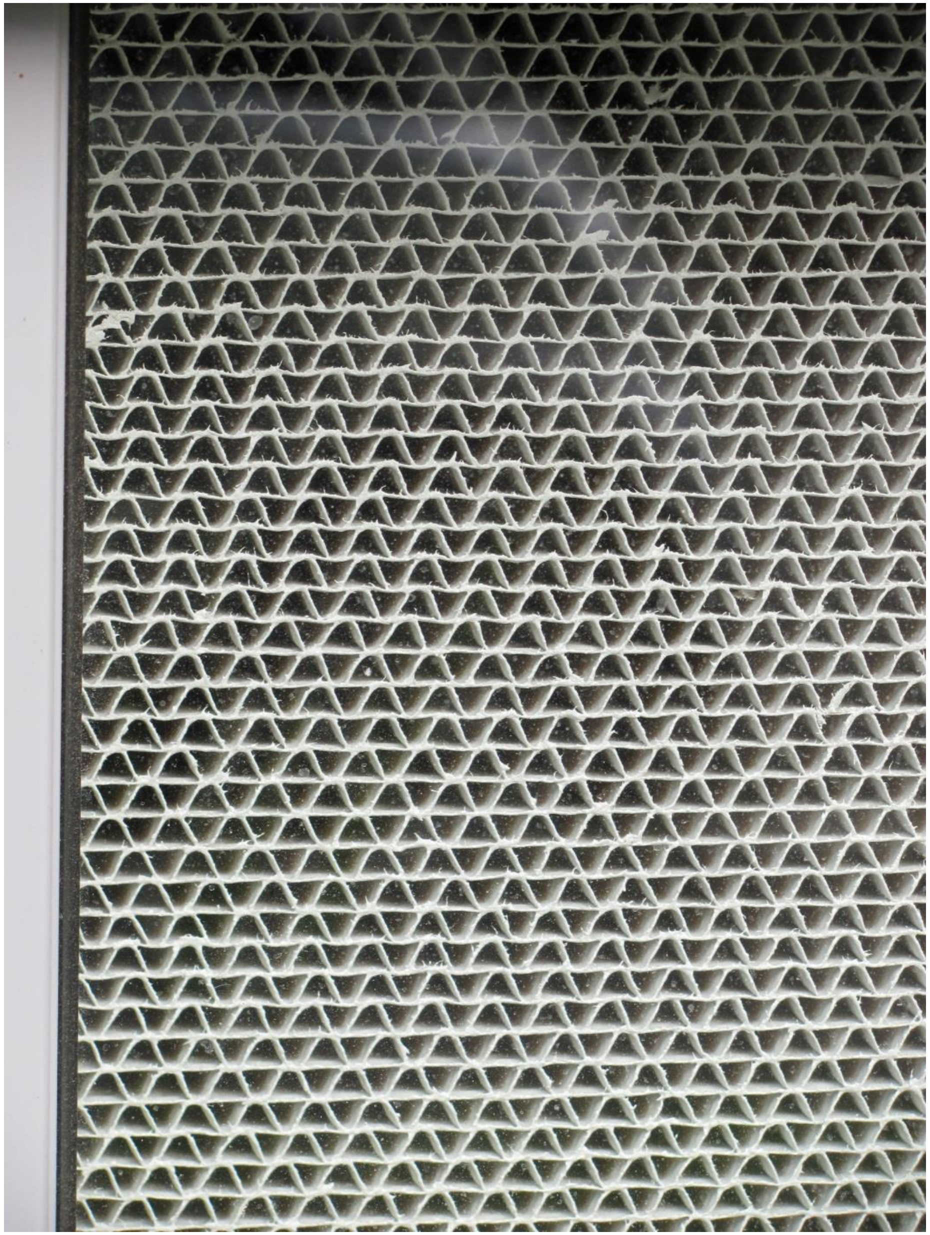
Figure 18: The on-site preparation is done by leveling laths. In-between the distribution system and supply pipes are installed.

Figure 19: The solar collectors were integrated into the prefabricated modules.
(Source: Gap-Solution GmbH)

The renovation proceeded very smoothly:

The on-site preparation comprised the installation of the levelling laths, where in-between the heat distribution panels and supply lines were mounted. Afterwards the remaining space was filled with rock-wool. The modules were brought by a low-loader to the building site, lifted by a truck-mounted crane to the facade. Additionally on each side two assembly operators supported the fitting procedure. After the entire facade was covered with the new modules the old windows were removed from the inside, the vapour barriers were sealed (building angles, window-reveal,...) and the collectors were connected to the supply pipes.

Figures 20-22: Sequence of assembly of the modules on the south-oriented façade
(Source: Gap-Solution GmbH)



Solar ‘honeycomb’ detail: Architekturburo Hohensinn, 2007-2010

Renovation design details

Façade solutions

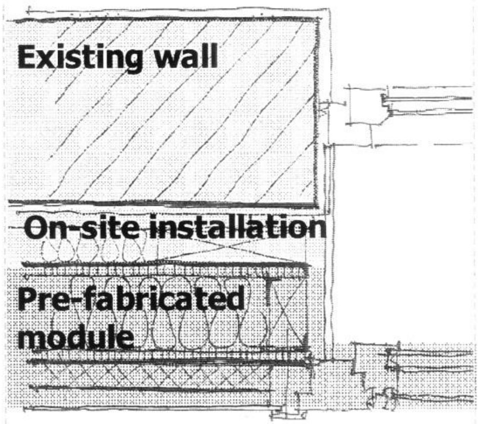


Figure 7: Pre-fabricated façade module

Layer composition of basic facade module

Existing wall	10 mm	Internal plaster
	300 mm	Existing exterior wall
	25 mm	External plaster
On-site installation	100 mm	Levelling laths In-between rock-wool
Pre-fabricated module	18 mm	OSB-board
	120 mm	Timber frame between rock wool
	15 mm	MDF- board
	30 mm	Solar comb
	29 mm	Rear ventilation
	6 mm	Toughened safety glass

- ‘On-site installation’ includes heating serpentine embedded in XPS board on face of original wall; principle by Austrian Architect, Walter Unterrainer, cold U-value 0.2 falls to 0.13 W/m^{2}K mean, and often below zero; predicted heat demand 12 kWh/m^2 annually, i.e. 3 kWh/m^2 below PassivHaus standard.